Low-cost drip irrigation – economic case study, Burdekin region

Grower: Joe Tama

The NQ Dry Tropics Project Catalyst provides an opportunity for sugarcane growers to work closely with technical specialists to examine innovative and aspirational practices that may enhance profitability, whilst reducing nutrient and pesticide losses from Burdekin farms and improving water quality entering the Great Barrier Reef. Moreover, it facilitates the communication of trial results to other growers, serving as a catalyst to sustainable farming.

This case study investigates the economic feasibility of installing low-cost drip irrigation on Joe Tama's sugarcane farm at Inkerman in the Burdekin Delta. In particular, the costs to install the drip irrigation system are explored along with the differences in crop growing costs between Joe's furrow and drip irrigated blocks. Based on these costs, the study calculates the yield improvement needed by the drip system to breakeven economically with the furrow system and investigates how potential improvements in cane yield influence the profitability of the investment. Production from Joe's drip blocks are also examined to get an idea of how his system has been performing.

Project Catalyst is a pioneering partnership funded by the Coca-Cola Foundation, through the World Wide Fund for Nature, and delivered in partnership with the Department of Agriculture and Fisheries, Farmacist, Burdekin Productivity Services and the Burdekin Bowen Integrated Floodplain Management Advisory Committee Inc. (BBIFMAC).

Key findings:

- Compared to Joe's furrow irrigation, drip has relatively higher electricity and crop nutrition expenses that outweigh savings in labour, cultivation and weed control expenses.
- For Joe's drip investment to recover the installation costs and higher growing costs (and breakeven economically with his furrow system), a cane yield increase of between 13 and 16 TCH during each crop class is required, which adds up to an extra 126 to 128 TCH (in total) over two crop cycles.

Low-cost drip irrigation

The use of drip irrigation can increase the efficiency of water applications and reduce water losses from runoff and deep drainage when compared to furrow irrigation. As irrigation can be the main conduit for the movement of nutrients and pesticides, improvements in application efficiency are likely to reduce their loss into the environment.

Drip tape also enables irrigators to apply nutrients through fertigation. This technique enables users to apply nutrients in small doses to mimic crop requirements, as opposed to the common practice of applying large quantities of nutrients in a single application.

Since the soil surface is not usually wet up when drip irrigating, weed pressures are relatively lower than what is common on furrow irrigated blocks. Consequently, weed management with drip irrigation is easier and requires less control (i.e. herbicide operations).

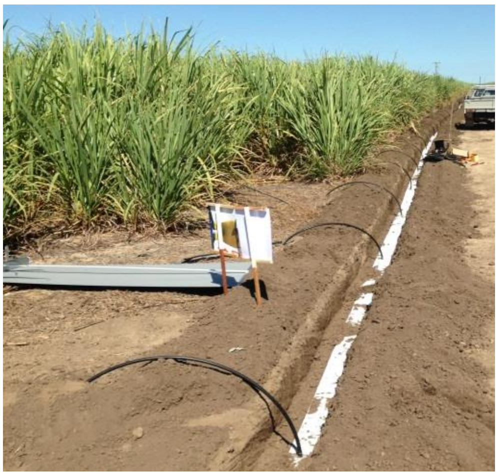
Water applied with drip irrigation does not need to infiltrate into the bed profile. Accordingly, drip irrigation systems usually require lower rates of soil ameliorants (e.g. gypsum or lime) to be applied in comparison to furrow systems.

Since the soil profile is only partially wetted on drip irrigated blocks compared to furrow, the dry-down period prior to harvest is significantly reduced (usually to around 5–6 weeks). As a result the vigour of ratoon crops improves, which can extend the crop cycle by one or two additional ratoons.

Along with the benefits already mentioned, there have been several instances where drip irrigation has substantially improved cane yields. See

Shannon[1] (2014) for a comprehensive review of drip irrigated sugarcane in the Burdekin.

Image 1: Drip irrigation (PolyNet® sub-mains)



Source: DAF, 2015

Trial site description

Joe Tama has been struggling with poor yielding blocks on his farm in recent years due largely to the salinity of the irrigation water supply. The saline[2] irrigation water has been limiting yields particularly in ratoon crops and has resulted in some first ratoon crops being ploughed out. Joe has a history of using drip irrigation for horticultural crops, such as eggplant and capsicums, so it was a natural progression to try to counter the effects of saline irrigation on sugarcane using a drip system. In 2013, drip irrigation was installed on two blocks covering an area of 10 hectares. Table 1 provides a summary of the characteristics of the trial blocks that were planted in 2013.

Table 1: Characteristics of trial site

Element	Description
Soil type:	Medium clay with sodic sub soil
Location:	Inkerman, Burdekin Delta
Water supply:	Bore/Aquifer
Crop stage:	1st ratoon harvested in 2015
Variety:	Q183
Row spacing:	1.83m dual rows (drip)

In order to provide a comparison between conventional furrow irrigation and Joe's drip irrigation site, information from an adjacent furrow irrigated block was used in the analysis. The furrow block has similar characteristics to the drip blocks including water quality (saline) and soil type.

Methodology

Five key questions are examined in this study. The first question explores the costs to install drip irrigation at Joe's farm, while the second question compares the irrigating costs of his furrow and drip irrigated blocks. The main cost differences include electricity, labour, crop nutrition, cultivation and weed control expenses.

The Farm Economic Analysis Tool (FEAT) was used to evaluate the revenues and costs of each treatment. From these results, the gross margin[3] of each treatment is compared. The analysis uses a discount rate of 7 per cent, a labour cost of $30 per hour and the five-year average (2010-14) sugar price of $430/t. Input prices were collected from local suppliers in 2015.

Image 2: Joe with the drip irrigated crop

Source: Farmacist, 2014

Drawing on the installation costs and differences in irrigation costs, the third research question investigates how much extra (or less) cane needs to be grown for the drip system to recover the installation costs and breakeven economically with the furrow irrigated system.

To calculate revenue, the breakeven analysis uses the production estimates for the furrow and drip

[1] Shannon, E. (2014) Market and Literature Review: Low Cost Alternative Irrigation, NQ Dry Tropics, Townsville.
[2] High electrical conductivity.

[3] The gross margin is a measure of profitability and is calculated by subtracting variable growing expenses (e.g. cartage and fertiliser) from revenue.

irrigated blocks[4] that are outlined in Table 2; cane yield (TCH) and commercial cane sugar (CCS).

These figures are derived from 2014 plant crop harvest data for the furrow irrigated block and assume that yield declines by 10 per cent in each of the successive ratoons. By using the yields from the furrow irrigated block as a benchmark, it is possible to calculate the yield necessary for the drip blocks to attain the same level of profitability.

Table 2: Estimated cane yield (TCH) and CCS

	Cane yield		CCS
	Furrow	*Drip*	
Plant cane (actual)	69	69	14.5
1st ratoon (-10%)	62	62	14.5
2nd ratoon (-10%)	56	56	14.5
3rd ratoon (-10%)	n/a	51	14.5
4th ratoon (-10%)	n/a	45	14.5

Uncertainty exists around the influence drip irrigation will have on crop yields. To incorporate this factor, the fourth question examines how potential cane yield improvements would influence the profitability of an investment into drip.

The fifth question explores how Joe's drip system has been performing so far? In particular, plant and first ratoon crop harvest data from the furrow and drip irrigated blocks are compared.

Drip installation costs

Drip irrigation is expensive to install with conventional systems generally in the order of $7,000 per hectare. However, there are some low cost alternatives available. For example, Joe has substituted more expensive options like gravel filters and PVC supply sub-mains with low cost options including a screen filter and sunny hose sub-mains. With these options, Joe has been able to limit his expenditure to $3,200 per hectare. Table 3 shows a breakdown of Joe's investment into drip irrigation.

[4] Estimates of production for the furrow block during third and fourth ratoon are required to calculate the yield increase necessary for the drip blocks to breakeven with the furrow block.

Table 3: Breakdown of drip investment

Item	Expenditure ($)	($/ha)
Drip tape	$27,000	$2,698
Sunny hose	$2,000	$200
Screen filter	$580	$58
Pump adapter, fittings and pipe connections	$1,000	$100
Installation[5]	$1,440	$144
Total	**$32,020**	**$3,200**

Crop growing expenses

The differences in production costs between the irrigation systems are outlined in Tables 4, 5 and 6, which represent the fallow, plant and ratoon crop classes, respectively. Growing expenses that were found to be different between the two irrigation systems include:

- Electricity costs[6]
- Crop nutrition expenses[7]
- Labour time spent on irrigation tasks
- Cultivation/machinery costs
- Soil ameliorant costs[8] (gypsum)
- Levelling costs[9]
- Weed control expenses
- Repairs and maintenance (R & M) of the irrigation systems

The first table (see Table 4) examining fallow costs identifies substantial differences in levelling and gypsum application expenses.

[5] Contractors and labour.
[6] Because of changes to water use and pump pressure requirements.
[7] Due to a shift to fertigation.
[8] Joe normally applies gypsum during the fallow in every crop cycle. Shifting to drip irrigation enables Joe to drop his usual application rate by half.
[9] Joe re-levels the furrow irrigated blocks approximately every second crop cycle. Drip-irrigated blocks do not usually require re-levelling.

Table 4: Variable costs - Fallow ($/ha)

	Furrow	Drip	*difference*
Laser levelling[10]	$194	$0	*-$194*
Gypsum	$800	$400	*-$400*
Cultivation	$501	$501[11]	*$0*
Weed control	$29	$29	*$0*
Total	**$1,524**	**$930**	***-$594***

In plant cane, the furrow block received several cultivation operations[12]. In comparison, the drip blocks were only bed formed. Furthermore, the furrow block required an additional weed control operation during plant cane (see costs in Table 5).

Irrigation tasks are another area where the furrow system requires far greater labour requirements including opening/closing valves, changing sets and cups as well as moving plastics during harvest season. In comparison, the drip system only requires 10 minutes per irrigation as the timer shuts the irrigation off when prescribed.

There are also some disparities associated with irrigation R & M. While both systems require repairing burn-outs and changing packings, the cost to replace fluming and cups for furrow irrigation can add up. Nevertheless, these savings can be eroded by pest incursions. Indeed, Joe suffered problems after harvesting his plant cane green, which has convinced him to return to burnt cane harvesting the drip blocks. Burnt cane harvesting also costs Joe around $0.80 per tonne less than green cane harvesting.

In contrast, the drip system had higher crop nutrition expenses during both the plant and first ratoon crop due primarily to higher liquid fertiliser prices. Moreover, the drip system has so far demanded far more electricity[13].

Table 5: Variable growing costs - Plant cane ($/ha)

	Furrow	Drip	*diff.*
Cultivation	$130	$29	*-$101*
Planting[14]	$846	$826	*-$20*
Crop nutrition	$690	$898	*$208*
Weed control	$59	$33	*-$26*
Irrigation - *Electricity*	$380	$743	*$363*
- *Labour*	$234	$60	*-$174*
- *R & M*	$60	$45	*-$15*
Total	**$2,399**	**$2,634**	***$235***

During the first ratoon, cultivation operations on the furrow block included two passes with a grubber and one pass with hill-up boards, whereas the drip blocks were not cultivated.

Overall, the drip system saves from having no laser levelling expenses and lower gypsum application costs in the fallow (see Table 6). However, during both the plant and first ratoon crops, the drip system accrues relatively higher irrigation electricity costs and crop nutrition expenses that outweigh savings in irrigation labour, cultivation and weed control expenses[15].

Table 6: Variable growing costs - Ratoons ($/ha)

	Furrow	Drip	*diff.*
Cultivation	$81	$0	*-$81*
Crop nutrition	$429	$636	*$207*
Weed control	$39	$31	*-$8*
Irrigation - *Electricity*	$313	$686	*$373*
- *Labour*	$192	$54	*-$138*
- *R & M*	$50	$41	*-$9*
Total	**$1,104**	**$1,448**	***$344***

Breakeven analysis

Figure 1 compares the gross margins of both irrigation systems for each crop class during the first crop cycle when assuming that the drip irrigated system has the same production as the

[10] Represents the cost per crop cycle.
[11] Cultivation expenses for drip reflect the first crop cycle. Joe plans to spray-out the final ratoon on the drip blocks and plant directly into the row using a double disc opener (without cultivating).
[12] Operations included: two passes with grubber; one pass marking out; one pass hilling up, and; one pass with cutaway.
[13] The relative usage of electricity by each system will continue to be monitored.

[14] Planting costs were different due to slight variations in the amount of cane planted for 1.83m dual rows (drip blocks) and 1.52m single rows (furrow block).
[15] To investigate profitability over the crop cycle, all successive ratoons are forecasted to have production costs equivalent to those accrued during the first ratoon.

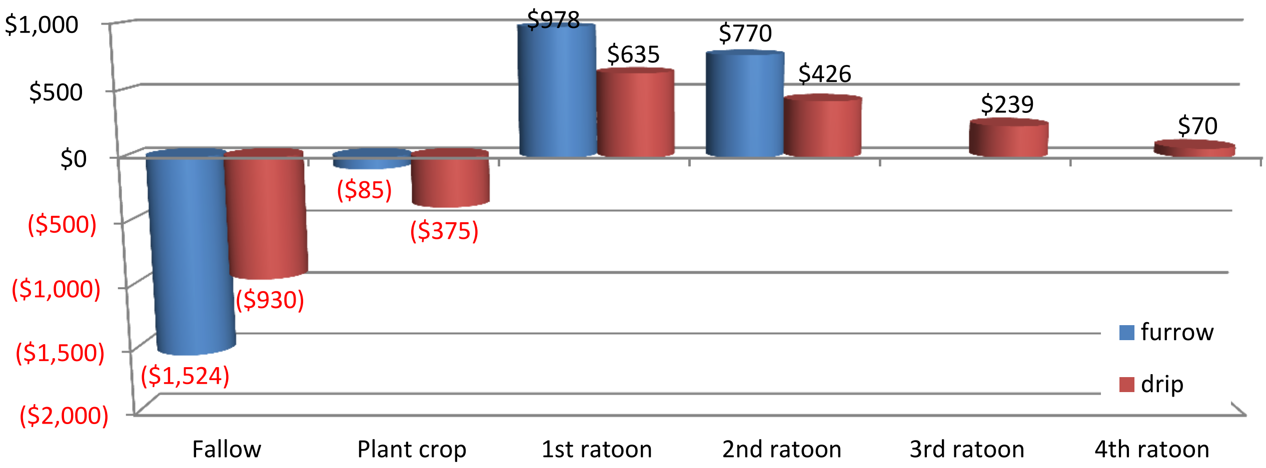


Figure 1: Gross margin during each crop class ($/ha)

furrow. Moreover, the gross margins for each extended ratoon (third and fourth ratoons) are included.

To put these cost differences into perspective, Figure 2 examines the yield change required for the drip-irrigated blocks to realise the same profitability as the furrow block, when assuming a constant CCS level. To breakeven, the drip blocks need a comparatively higher yield to generate enough revenue to cover both the higher production costs and repay the capital expenditure into drip irrigation.

In the case of the drip irrigation scenario taken to the third ratoon, an extra 15.7 TCH more than the furrow irrigated block during each crop class is necessary to breakeven, which adds up to an extra 126 TCH over two crop cycles. Comparatively, if the crop is taken to the fourth ratoon, only a relative yield increase of 12.8 TCH is needed during each crop class, which adds up to a similar total of 128 TCH over two crop cycles.

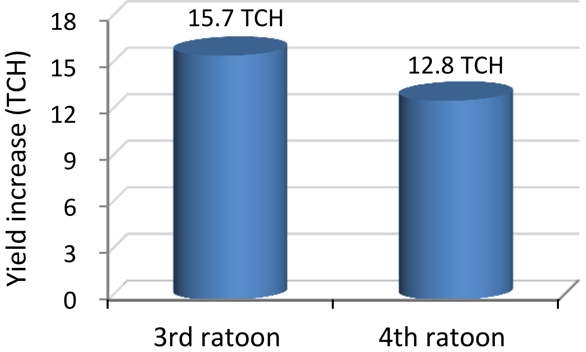


Figure 2: Yield increase required to breakeven with furrow block (TCH)

Figure 3 presents the annualised benefit (AEB[16]) of investing in each of the drip irrigation scenarios. The annualised benefit takes into account the capital expenditure into drip as well as differences in growing costs. It also enables a comparison of each investment's average annual return over the life of the investment.

The graph builds on the preceding chart by enabling readers to examine the comparative profitability of investing in each drip scenario, based on expected improvements in cane yields above those produced by the furrow irrigated block.

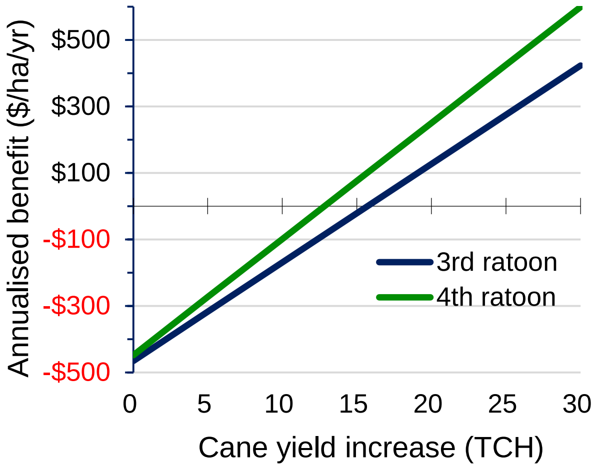


Figure 3: Sensitivity of economic outcome to variations in cane yield

[16] The Annualised Equivalent Benefit (AEB) is a transformation of an investment's net present value. It is a useful measure to compare the performance of investments that produce benefits over different horizons.

For example, if the grower perceives that the drip scenario taken to fourth ratoon will boost cane yields by 20 TCH, during all crop classes relative to the furrow irrigated block, then they could expect a comparative improvement in earnings by around $250 per hectare every year over the life of the investment.

Production from Joe's drip blocks

As the trial is not replicated, it is difficult to ascertain whether differences in yield between the furrow and drips block is due solely to drip irrigation. But to give an indication of how the drip blocks have performed so far in the trial, Table 7 shows the 2014 and 2015 harvest results from both the drip and furrow blocks. However, as a replicated and randomised trial design has not been employed, it is important to acknowledge the inherent limitations of the comparison.

The 2014 plant cane harvest results identify that the drip irrigated blocks produced both higher cane yield (by 11 TCH) and CCS (by 0.6 units) than the furrow block. After harvesting the plant crop, Joe's drip tape was severely damaged by rats, which interrupted his irrigation scheduling and devastated his first ratoon crop's cane yield. He believes that harvesting the plant crop green contributed significantly to the rat infestation.

As a result, Joe spent around $2,000 on new tape and fittings and expended 60 labour hours to repair the infrastructure. He also opted to spray out the crop to start over and now plans to burn prior to harvest.

Table 7: Cane yield (TCH) and CCS results

	Drip[17]		Furrow	
	TCH	*CCS*	*TCH*	*CCS*
Plant - 2014	80	15.1	69	14.5
1st ratoon - 2015	38	14.3	53	15.1
Total	**118**	**14.7**	**122**	**14.8**

In 2015, Joe expanded his drip system by installing another four hectares of drip infrastructure on an adjacent block using PolyNet® sub-mains (see Image 1). By better utilising his drip setup, Joe may be able to decrease his average costs per hectare.

[17] Weighted average of the drip irrigated blocks.

For example, by utilising some of his existing infrastructure (pump, pump adapter, filter, etc.), Joe was able to install the additional four hectares at a lower per hectare cost than for the original installation ($2,875/ha, or $11,500 in total).

Conclusion

Drip irrigating sugarcane can provide a range of benefits. This case study explored the costs to install drip and compared the growing costs of two drip irrigated blocks that Joe installed in 2013 with an adjacent block that is furrow irrigated. Furthermore, two extended ratoon scenarios were examined to determine the cane yield improvement necessary for the Joe's drip investment to breakeven with the furrow block.

The cost comparison found that the drip system had relatively higher electricity and crop nutrition expenses that outweighed savings in irrigation labour, cultivation and weed control expenses. The breakeven analysis indicates that a cane yield increase of between 13 and 16 TCH during each crop class (or a total of 126 to 128 TCH over two crop cycles) is necessary to afford the extended ratoon scenarios the same profitability as the furrow block.

An analysis of Joe's production at the trial site found that the drip irrigated blocks performed relatively better during the plant crop, but the first ratoon crop yields were devastated by rat damage. Future information from the drip irrigated blocks will improve our understanding of Joe's investment.

Acknowledgements

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